Recoil separator capabilities for heavy element research and an opportunity for second generation chemistry studies

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Compound nucleus recoil separators have become the tool of choice in the discovery and study of nuclear properties of transactinide isotopes. An overview of recoil separator principles, capabilities and limitations are presented. The recoil separators currently active in the study of heavy element isotopes are presented. An attempt is made to compare the efficiency, selectivity, sensitivity, and resolution of present-day separators for heavy element studies.

The factors limiting efficiency of recoil separators are dominated by energy loss and scattering of compound nucleus evaporation residues in the target material, together with the angular and velocity acceptance of the separators. Selectivity and sensitivity are closely related, with selectivity most dependent on the separator's ability to suppress unwanted nuclear reaction products, and sensitivity strongly dependent on the detection techniques used. Resolution refers to the ability of the separator/detector system to give information on the Z, A, and/or energy of the heavy element isotopes. The small cross sections and resulting low production rates for heavy element isotopes present the most fundamental limitation in transactinide science. Thus, the available integrated luminosity available to an accelerator-separator combination is as important as the capabilities of the separator itself. All of these factors are discussed for the existing separators, and options for future separator programs are presented.

The Berkeley Gas-filed Separator has been coupled with a gas-jet device to provide pre-separated isotopes for transactinide chemical studies. This technique is described, and the new capabilities it provides are discussed. An international effort to design and build a new separator specifically for transactinide chemical studies, "ChemSep," has begun.